

PAEDIATRIC HOSPITAL LEVEL STANDARD TREATMENT GUIDELINES AND ESSENTIAL MEDICINES LIST
CHAPTER 23: PAEDIATRIC INTENSIVE CARE
NEMLC 8 DECEMBER 2022

MEDICINE AMENDMENTS

SECTION	MEDICINE	ADDED/DELETED/NOT ADDED
23.1 Rapid Sequence Intubation	Rocuronium	Dose and duration of effect amended
23.6.2 Potassium abnormalities in ICU	Potassium IV	Dosing clarified
<i>Hypokalaemia</i>		
<i>Hyperkalaemia</i>	Sodium polystyrene sulfonate	Not added
23.7 Traumatic Brain Injury and Neuroprotection in ICU		
<i>Analgesedation</i>	Ketamine	Retained
<i>Seizure prophylaxis</i>	Sodium valproate IV	Not added
	Phenobarbitone	Not added
23.8 Inotropes and vasopressors	Noradrenaline	Not added

23.1 Rapid Sequence Intubation

Rocuronium: dose and duration of effect amended for rapid sequence induction.

Previously the rocuronium dose was aligned with the anaesthesia chapter recommendations, however this was amended in line with proposed dosing for ICU rapid sequence induction.¹

Text updated as follows:

Drug	IV Dose	Time to Effect	Duration of Effect
Rocuronium	0.3 to 1.1 mg/kg	1-3 minutes	30-60 - 90 minutes

23.2 Analgesedation

Comfort scale was updated to the COMFORT B Score.

¹ Correia MR, Rapid Sequence Induction of Anaesthesia in the Paediatric Patients: Contronversies and proposed protocol. South African Family Practice. 2016, 58(3): S32-S35.

23.6.2 Potassium abnormalities in ICU

Hypokalaemia

Potassium IV: Dosing clarified

A safety box was added to outline precautions to take with administering IVI potassium.

Additionally, a statement was included to recommended oral potassium in stable patients with severe hypokalaemia. The use of oral/enteral potassium has been shown to have similar efficacy to IV potassium replacement in cardiac ICUs.^{2,3}

The text was updated as follows:

Replacement of Potassium in ICU:

If potassium 2.5 – 3.4 mmol/l – replace orally - 1mmol/kg per dose

- Potassium chloride tablets (600mg) = 8 mmol
- Mist potassium citrate 30% suspension = 2.8 mmol/ml

If potassium < 2.5 mmol/l will need intravenous replacement

- » IV potassium only to be used where appropriate monitoring is available which must include continuous ECG and bedside serum potassium/blood gas analysis.
- » Ensure slow administration, over 4 hours.

- **Always discuss with a specialist first before commencing any IVI potassium**
- Replacement dose = 1 - 2 mmol/kg (given slowly over 4 hours)
- Maximum rate of replacement 0.5 mmol/kg/hour
- **Recommended dose = 1.2 mmol/kg = 0.3 mmol/kg/hour for 4 hours**
- 15% KPO₄ and 15% KCL both contain 2mmol/ml of potassium
- ECG monitoring is strongly recommended during IV potassium replacement

Example of IV replacement in a 10kg child

Dose = 1.2 mmol x 10 kg = 12 mmol of potassium

= 6 mls of 15% potassium solution

Recommended: Add the 6 mls of potassium (either Cl or PO₄ - depending on the patients clinical characteristics) to 14 mls of 0.9% saline, to create a 20 ml solution. Then administer the solution at 5 mls/hour over 4 hours.

Please note that this only holds true for a child who is not receiving any additional potassium intravenously.

Note: In stable patients with severe hypokalaemia, slow correction with oral potassium supplementation can be considered in non-ICU environments.

Hyperkalaemia

Sodium polystyrene sulfonate: Not added

² Siddiqui NR, Mercant Q, Hasan BS, Rizvi A, Amanullah M, Rehmat A, ul Haq A. Comparison of enteral versus intravenous potassium supplementation in hypokalaemia in paediatric patients in intensive care post cardiac surgery: open-label randomised equivalence trial. BMJ Open. 2017, 7: e011179.

³ Moffett BS, McDade E, Rossano JW, Dickerson HA, Nelson DP. Enteral potassium supplementation in pediatrics cardiac intensive care unit: evaluation of a practice change. Pediatr Crit Care Med. 2011, 12 (5): 552-554.

An external comment was received querying whether sodium polystyrene sulfonate should be included in the management of hyperkalaemia. The Committee noted that this agent was not part of the management for acute hyperkalaemia, and may deter from the required management.

23.7 Traumatic Brain Injury and Neuroprotection in ICU

Analgosedation

Ketamine: retained

An external commenter indicated that ketamine is a relative contraindication with raised intracranial pressure (ICP). The Paediatric Committee indicated that this is no longer considered to be true. Ketamine has not been shown to increase and may in fact decrease intracranial pressure.⁴ A systematic review evaluating ketamine in patients with acute brain injury (11 studies) found that the overall evidence concerning ketamine in brain injury is low. Of the 11 studies, 2 showed a small increase in ICP and 2 found a decrease in ICP. No evidence of harm was found with the use of ketamine in patients with acute brain injury.⁵

Seizure prophylaxis

Sodium valproate: Not added

Phenobarbitone: Not added.

An external comment was received indicating that sodium valproate and phenobarbitone could also be considered in seizure prophylaxis. The Paediatric Committee noted that although these agents are used in practice, the use is not evidence based. Phenytoin was retained as only option.

Feeds

The following caution was added:

Avoid nasogastric tubes if a base of skull fracture is suspected.

23.8 Inotropes and vasopressors

Noradrenaline: Not added.

An external commenter proposed that addition of noradrenaline. It was discussed that this could not be added as it was only available via section 21 application.

⁴ Godoy DA, Badenes R, Relosi P, Robba C. Ketamine in acute phase of severe traumatic brain injury “an old drug for new uses?” Critical Care. 2021, 25:19

⁵ Gregers MCT, Mikkelsen S, Lind KP, Brochner AC. Ketamine as an anesthetic for patients with acute brain injury: A systematic review. Neurocrit Care. 2020, 33: 273-282.

23.10 ICU medications

The table of ICU medications was reformatted in alphabetical order.

PREVIOUSLY ACCEPTED AMENDMENTS

SECTION	MEDICINE	ADDED/DELETED/NOT ADDED
23.1 Rapid Sequence Intubation	Propofol	Added
	Ketamine	
	Etomidate	
	Fentanyl	
	Midazolam	
	Rocuronium	
	Suxamethonium	
	Atropine OR Glycopyrrrolate	
	Lidocaine	
23.2 Analgosedation	Morphine	Added for continuous mechanical ventilation
	Fentanyl	
	Midazolam	
	Lorazepam	
	Diazepam	
	Propofol	
	Ketamine	
	Ketamine	
	Fentanyl	Added for procedural sedation
	Midazolam	
23.4 Post Cardiac-Arrest Syndrome	Maintenance fluids	Requirements and composition added
23.6.1 Dysnatraemias in ICU <i>Management of hypernatremias</i>	Desmopressin	Refer to Endocrine Chapter added
23.6.2 Potassium abnormalities in ICU <i>Hypokalaemia</i>	Potassium, oral	Added
	Potassium, IV	Added
<i>Hyperkalaemia</i>	Calcium chloride/calcium gluconate	Added
	Salbutamol Nebbs/salbutamol IVI	Added
	Sodium bicarbonate 8.5%	Added
	Dextrose/insulin	Added
23.6.3 Magnesium Abnormalities in ICU <i>Hypomagnesaemia</i>	Magnesium sulphate IVI	Added
	Calcium gluconate, IVI	Added
23.6.4 Calcium abnormalities in ICU <i>Hypocalcaemia</i>	Calcium chloride, IVI	Added
	Calcium gluconate, IVI	Added

23.6.5 Phosphate Abnormalities in ICU <i>Hypophosphataemia</i>	Potassium phosphate, IVI	Added
<i>Hyperphosphataemia</i>	Calcium carbonate	Added
23.7 Traumatic Brain Injury and Neuroprotection in ICU	Corticosteroids	Not added
<i>Analgosedation</i>	Morphine	Added
	Fentanyl	
	Midazolam	
	Paracetamol	
<i>Seizure prophylaxis</i>	Phenytoin	Added
<i>Trachial Suctioning</i>	Non-depolarising agents	Added
<i>Stress ulcer prophylaxis</i>	PPIs	Added
<i>Acute management of raised intracranial pressure</i>	Sodium Chloride 5%	Added
	Sodium Chloride 3%	Added
	Mannitol	Added
23.8 Inotropes and vasopressors	Dobutamine	Guidance and details added
	Dopamine	
	Adrenaline	
	Phenylephrine	
23.9.1 Thromboprophylaxis in ICU	Low molecular weight heparin	Added
	Unfractionated heparin	Added
23.9.2 Treatment of VTE	Low molecular weight heparin	Added
	Unfractionated heparin	Added
	Warfarin	Added
23.10 ICU medications	Adrenaline	Guidance provided
	Dobutamine	
	Amiodarone	
	Lidocaine	
	Labetalol	
	Furosemide	
	Magnesium sulphate	
	Atropine	
	Glycopyrrolate	
	Salbutamol	
	Intravenous immunoglobulin	
	Hydrocortisone	
	Dexamethasone	
<i>Vasopressors and inotropes</i>	Adrenaline	Concentration and formula provided
	Dobutamine	
	Dopamine	
	Phenylephrine	

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MEDICINE AMENDMENTS

SECTION	MEDICINE	ADDED/DELETED/NOT ADDED
23.1 Rapid Sequence Intubation	Propofol	Added
	Ketamine	
	Etomidate	
	Fentanyl	
	Midazolam	
	Rocuronium	
	Suxamethonium	
	Atropine OR Glycopyrrolate	
	Lidocaine	
23.2 Analgosedation	Morphine	Added for continuous mechanical ventilation
	Fentanyl	
	Midazolam	
	Lorazepam	
	Diazepam	
	Propofol	
	Ketamine	
	Ketamine	Added for procedural sedation
	Fentanyl	
	Midazolam	
23.4 Post Cardiac-Arrest Syndrome	Maintenance fluids	Requirements and composition added
23.6.1 Dysnatraemias in ICU <i>Management of hypernatremias</i>	Desmopressin	Refer to Endocrine Chapter added
23.6.2 Potassium abnormalities in ICU <i>Hypokalaemia</i>	Potassium, oral	Added
	Potassium, IV	Added
<i>Hyperkalaemia</i>	Calcium chloride/calcium gluconate	Added
	Salbutamol Nebbs/salbutamol IVI	Added
	Sodium bicarbonate 8.5%	Added
	Dextrose/insulin	Added
23.6.3 Magnesium Abnormalities in ICU <i>Hypomagnesaemia</i>	Magnesium sulphate IVI	Added
<i>Hypermagnesaemia</i>	Calcium gluconate, IVI	Added
23.6.4 Calcium abnormalities in ICU <i>Hypocalcaemia</i>	Calcium chloride, IVI	Added
	Calcium gluconate, IVI	Added

23.6.5 Phosphate Abnormalities in ICU	Potassium phosphate, IVI	Added
<i>Hypophosphataemia</i>		
<i>Hyperphosphataemia</i>	Calcium carbonate	Added
23.7 Traumatic Brain Injury and Neuroprotection in ICU	Corticosteroids	Not added
<i>Analgo-sedation</i>	Morphine	Added
	Fentanyl	
	Midazolam	
	Paracetamol	
<i>Seizure prophylaxis</i>	Phenytoin	Added
<i>Trachial Suctioning</i>	Non-depolarising agents	Added
<i>Stress ulcer prophylaxis</i>	PPIs	Added
<i>Acute management of raised intracranial pressure</i>	Sodium Chloride 5%	Added
	Sodium Chloride 3%	Added
	Mannitol	Added
23.8 Inotropes and vasopressors	Dobutamine	Guidance and details added
	Dopamine	
	Adrenaline	
	Phenylephrine	
23.9.1 Thromboprophylaxis in ICU	Low molecular weight heparin	Added
	Unfractionated heparin	Added
23.9.2 Treatment of VTE	Low molecular weight heparin	Added
	Unfractionated heparin	Added
	Warfarin	Added
23.10 ICU medications	Adrenaline	Guidance provided
	Dobutamine	
	Amiodarone	
	Lidocaine	
	Labetalol	
	Furosemide	
	Magnesium sulphate	
	Atropine	
	Glycopyrrolate	
	Salbutamol	
	Intravenous immunoglobulin	
	Hydrocortisone	
	Dexamethasone	
<i>Vasopressors and inotropes</i>	Adrenaline	Concentration and formula provided
	Dobutamine	
	Dopamine	
	Phenylephrine	

General

Intensive care and anaesthetics was previously combined into one chapter. The ICU guidance was very limited, including only: Sedation for intensive care procedures and parenteral nutrition.

The presented Paediatric Intensive Care Chapter has been separated from Anaesthetics and expanded significantly.

Medication recommendations are largely in line with other areas of the STGs, however discussed below.

The following new sections have been added:

- Rapid sequence intubation
- Analgosedation
- Post cardiac arrest syndrome – with referral to Emergencies and Trauma Chapter
- Fluids in ICU
- Electrolyte abnormalities
- Traumatic Brain Injury
- Inotropes and Vasopressors
- Venous Thrombo-embolism
- ICU Medications (including commonly used medicines and details for administration and compatibility)

23.1 Rapid Sequence Intubation

Previously included a section in sedation for ICU procedures. The below agents have been included. All previously included in the chapter with the exception of etomidate. This is a new addition in line with the Anaesthetics chapter and in line with Adult Hospital level.

Propofol

Ketamine

Etomidate

Fentanyl

Added

Midazolam

Rocuronium

Suxamethonium

Atropine OR Glycopyrrrolate

Lidocaine

23.2 Analgosedation

New section added, with the following agents included.

Morphine	
Fentanyl	
Midazolam	Added for continuous mechanical ventilation
Lorazepam	
Diazepam	
Propofol	
Ketamine	Added for procedural sedation
Ketamine	
Fentanyl	
Midazolam	

Recommendations for medicines in line with those in the Paediatric Pain and Anaesthetic Chapters.

23.5 Fluids in ICU

Maintenance fluids Requirements and composition added

- A section on fluid use in ICU was included. This section provides guidance and considerations for fluid use.
- A table of fluid requirements for critically ill children was added
- A table of the composition of commonly used crystalloids was added.

23.6.1 Dysnatraemias in ICU

<i>Management of hypernatremias</i>	Desmopressin	A referral to the Endocrine Chapter, Diabetes Insipidus section for use of desmopressin was added.
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23.6.2 Potassium abnormalities in ICU

<i>Hypokalaemia</i>	Potassium, oral	Added	Included in Alimentary Tract Chapter (dosing slightly different in ICU section)
	Potassium, IV	Added	
<i>Hyperkalaemia</i>	Calcium chloride/calcium gluconate	Added	Calcium gluconate included in Nephrology Chapter for hyperkalaemia. Calcium chloride

			added for more severe hyperkalaemia.
	Salbutamol Nebs/salbutamol IVI	Added	Included in Nephrology Chapter
	Sodium bicarbonate 8.5%	Added	4.2% included in Nephrology Chapter
	Dextrose/insulin	Added	Included in Nephrology Chapter

23.6.3 Magnesium Abnormalities in ICU

<i>Hypomagnesaemia</i>	Magnesium sulphate IVI	Added
<i>Hypermagnesaemia</i>	Calcium gluconate, IVI	Added

23.6.4 Calcium abnormalities in ICU

<i>Hypocalcaemia</i>	Calcium chloride, IVI	Added
	Calcium gluconate, IVI	Added

23.6.5 Phosphate Abnormalities in ICU

<i>Hypophosphataemia</i>	Potassium phosphate, IVI	Added
<i>Hyperphosphataemia</i>	Calcium carbonate	Added

23.7 Traumatic Brain Injury and Neuroprotection in ICU

Previously traumatic brain injury was not included in the Paediatric STGs and EML. A detailed section has been added to this chapter. The following medicine additions were made:

<i>General</i>	Corticosteroids	Not added	
<i>Analgesedation</i>	Morphine	Added	In line with recommendations in Pain Control Chapter
	Fentanyl		
	Midazolam		
	Paracetamol		
<i>Seizure prophylaxis</i>	Phenytoin	Added	Included as management option in CNS chapter
<i>Tracheal Suctioning</i>	Non-depolarising agents	Added	Added in Anaesthetic Chapter
<i>Stress ulcer prophylaxis</i>	Proton pump inhibitors	Added	Included for management in of burns in Emergency chapter

<i>Acute management of raised intracranial pressure</i>	Sodium Chloride 5%	Added	Both mannitol and 5% sodium chloride included in raised ICP section in CNS chapter. Sodium Chloride 3% new addition of continuous infusion post stat dose with 5% sodium chloride.
	Sodium Chloride 3%	Added	
	Mannitol	Added	

23.8 Inotropes and vasopressors

A section on inotropes and vasopressors was added. The following commonly used agents were added

Dobutamine

Dopamine

Guidance and

Adrenaline

details added

Phenylephrine

- Details on dosage, receptor activity, side effects and indications was added.
- A table outlining the recommended concentrations and a formula to calculate rate was added

Corticosteroids: Added

Calcium: Added

Corticosteroids and calcium included as additional medicine therapies for consideration with inotropes and vasopressors.

23.9.1 Thromboprophylaxis in ICU

Low molecular weight heparin

Added

Unfractionated heparin

Added

Previously thromboprophylaxis has not been included in the Paediatric STGs and EML. This section was added with recommendations based on the South African Paediatric Anticoagulation Guidelines.⁶

The recommendations were added as follows:

⁶ Schapkaite E, Sherman GC, Jacobson BF, Haas S, Buller HR, Davies V, et al. Paediatric anticoagulation guidelines. S Afr J Med. 2012;102(3):171-175

Drug	Dose	Comments
Low Molecular Weight Heparin (LMWH) e.g. Enoxaparin	< 2 Months of age: 0.75mg/kg/dose SC 12 hourly > 2 Months of age: 0.5mg/kg/dose SC 12 hourly	Avoid with renal insufficiency Monitoring: 0.2 – 0.4 anti-Xa U/ml (sample must be drawn in a non-heparinised syringe, 3-4 hours post dose)
Unfractionated Heparin	10 U/Kg/Hour IV as a continuous infusion	Not for routine use. Can be used in children with renal insufficiency, require surgery or have a high risk of bleeding

23.9.2 Treatment of VTE

<u>Low molecular weight heparin</u>	Added
<u>Unfractionated heparin</u>	Added
<u>Warfarin</u>	Added

Treatment of VTE added in line with recommendations in the Paediatric Blood and Blood forming organs chapter for management of venous thrombo-embolism disease.

23.10 ICU medications

A table with the following medications was added, outlining the product, indications, route of administration, dose, compatible fluids and incompatible fluids:

- Adrenaline
- Dobutamine
- Amiodarone
- Lidocaine
- Labetalol
- Furosemide
- Magnesium sulphate
- Atropine
- Glycopyrrolate
- Salbutamol
- Intravenous immunoglobulin
- Hydrocortisone
- Dexamethasone

It was felt that this is useful information for the ICU setting and commonly needed for reference by clinician.